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Application Bulletin

Blowers in Steam Compression

Application

Low-pressure steam exhaust from industrial operations such as evaporators or cookers is usually vented to the atmosphere or condensed in a cooling tower. Simultaneously, other plant operations may require intermediate-pressure steam at 20 to 25 PSIG. Instead of letting down high-pressure steam across a throttling valve to meet these needs, lowpressure waste steam can be mechanically compressed or boosted to a higher pressure so that it can be reused.

Vapor recompression involves incorporating a blower to increase the temperature of the latent heat in steam to render it usable for process duties. Recompression with a blower requires only a small fraction of the energy required to raise an equivalent amount of steam in a boiler.

Example

Consider a petrochemical plant that vents 8 PSIG steam to the atmosphere. At the same time, a process imposes a continuous requirement on the boiler for approximately 5,300 pounds per hour (lb/hr) of 23 PSIG steam. A Tuthill M-D Pneumatics™ 9012 PD Plus blower operating at 2100 RPM, 143 BHP (107 kW) accomplishes this task. In addition, approximately 0.6 GPM of 80° F condensate is injected into the blower to eliminate superheating of the steam, resulting in an additional 297 lb/hr of steam to the heating process.

Assuming electricity cost of $0.08/kWh, energy cost for the blower is calculated as follows:

143 BHP x 0.7457 * 8760 hr/yr x $0.08/kWh = $74,730

If an equivalent quantity of 23 PSIG steam (enthalpy for saturated steam at 37.7 PSIA is 1159 BTU/lb) were to be supplied by an 80% efficient naturalgas-fired boiler, the steam production costs with fuel priced at $8.00 per million Btu ($8.00/MMBtu) and 70°F feed water (enthalpy is 38 Btu/lb) are:

(5297 lb/hr x (1159-38) BTU/lb x 8760 hr/yr x $8.00/MMBTU) / 0.8) x 10-6 = $520,163

Annual energy savings by recompression:
$520,957 – 74,730 = $445,433 SAVINGS

MTE (Metric Tons Equivalent) CO_2 greenhouse gas emission savings:

Average pounds of CO_2 produced to generate 1.00 kWh = 1.341

Blower: 143 BHP x 0.7457 * 8760 hr/yr x 1.341 = 1252660 lbs.
1252660 / 2204.62 = 568.2 MTE CO_2

Average pounds of CO_2 produced by combustion of 1 MMBTU Natural Gas = 117.08

Boiler: ((5297 x (1159-38) x 8760) / 0.8) x 10-6 x 117.08 = 7810646 lbs.

7810646 / 2204.62 = 3453 MTE CO_2

Annual greenhouse gas emissions savings by recompression:
3453 MTE CO_2- 568.2 = 2884.8 MTE CO_2 SAVINGS

Adapted from an Energy TIPS fact sheet that was originally published by the Industrial Energy Extension Service of Georgia Tech University, and Steam Tip Sheet #11 published by US Department of Energy.

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